# XYLOPHAGOUS BEETLES AS INDICATORS FOR LONG-TERM TIME AND SPACE CONTINUITY OF FOREST HABITATS? PRELIMINARY PROJECT REPORT

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RÉSUMÉ. — *Les coléoptères xylophages comme indicateurs de la continuité spatio-temporelle à long terme des habitats forestiers? Rapport d'étude préliminaire.* — Plusieurs publications font état de ce que la continuité de l'habitat serait importante notamment dans le maintien de communautés de coléoptères xylophages en milieu boisé. La pertinence de ce facteur repose sur la faible mobilité de certains membres de cette communauté de coléoptères, les grands changements de la gestion forestière avec un manque de «habitat-arbres» et la structure spécifiquement métapopulationnelle de populations constituées par très peu d'individus (*e.g. Osmoderma eremita*). Notre projet est d'évaluer l'influence de la continuité de l'habitat sur la distribution dans les milieux boisés des coléoptères xylophages en comparant des données de populations à long terme (d'après le centre suisse de cartographie de la faune) à des évaluations des changements paysagers et forestiers. Le projet s'intéresse d'une part à des espèces remarquables en comparant le développement de populations ponctuelles durant le siècle passé avec des changements spécifiques d'habitats et de paysages dans les zones couvertes. D'autre part nous nous intéressons aux communautés de coléoptères en identifiant des «hotspots» locaux de biodiversité au sein du groupe et en comparant la distribution de ces «hotspots» à l'intensité des processus de changement paysager. Les premiers résultats montrent qu'il est nécessaire de diviser les coléoptères xylophages en groupes de mobilité différente. La continuité de l'habitat semble avoir une très forte influence sur les espèces à mobilité et dispersion faibles.

*Mots-clés*: Continuité de l'habitat, dispersion, changements du paysage, xylophages.

SUMMARY. — In several publications it was mentioned that habitat continuity seems to be a high value especially in maintaining the communities of xylophagous beetles in wooded land. Expectations about the relevance of this criterion are dealing with the low mobility of some members of this beetle community, the severe changes in forest management with a lack of "habitat trees", and the specific metapopulation structure of populations constituted by very few individuals (e.g. *Osmoderma eremita*). In our project we try to evaluate the influence of habitat continuity in wooded lands on the distribution of xylophageous beetles by comparing long-term population data (from the Swiss Cartographic Centre of Fauna) with assessments of landscape and forest changes. The project is dealing on one hand with single remarkable species comparing the development of population spots over the last century with specific habitat and landscape changes in the covered areas. On the other hand we are working with communities of beetles identifying local hotspots of biodiversity within the group and comparing the distribution of these hotspots with the intensity of landscape change processes. First results are showing that it is necessary to divide the xylophagous beetles into groups of different mobility. Habitat continuity seems to have a very severe influence on species with low mobility and dispersal.

*Keywords*: Habitat continuity, mobility, dispersal, landscape changes, xylophagous.

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The metapopulation theory founded mainly by Hanski (e.g. 1991, 1999) has implemented a strict focus on the role of space-time-dynamics in population biology. Especially in the cultural landscapes of Central Europe habitat-change-processes increased a lot during the last

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century. Most of our threatened species suffer under habitat loss itself and the growing lack of habitat connectivity. In metapopulation theory the extinction process of local populations starts with a disproportion between emigration and immigration in the habitat patches: Individuals emigrating from one patch with decreasing habitat quality cannot play their role as immigrants in another patch. This can have several reasons, for example:

— The habitats in all patches loose quality, no one is immigrating successfully.

— The surrounding of the patches does not allow successful migration activities.

— The fitness of the migrants is not sufficient for longer trips.

— The distance between the patches is too far for a successful migration.

If landscape heterogeneity is assumed on space and time levels, these possible reasons should not be verified only in one recent situation. Continuity of habitat can be also explained with "moving patches" during landscape changing processes. Hence the decision between protecting the habitat of threatened species on the same geographical place and managing their habitat in a dynamic system of developing and passing quality within functional distances should be a great task in nature conservation strategy.

Commonly the conservation of species described as mainly immobile follows the "protection on place"-strategy, whereas nature conservation especially in agricultural dominated landscapes assumes a mobility and flexibility of the population settlements.

Our running research project tries to identify the possibilities of a dynamic conservation strategy in forest area, using xylophagous beetles – differentiated after their mobility – as possible indicators for long-term habitat continuity. In general we therefore compare the distribution of the species groups with different mobility potentials with the distribution of their potential habitats in different time periods.

## MATERIAL AND METHODS

Although there is a long tradition of collecting beetles in Switzerland, the data base of xylophagous beetles cannot be declared as voluminous.

With the help of CSCF Neuchâtel (Centre Suisse de Cartographie de la Faune) – special thanks to Yves Gonseth – we were able to acquire valid data from whole Switzerland assessed between 1951 and 2004. Much older data were investigated from regional Entomological Collections (Geneva, Basel, ETH Zurich, St. Gallen, Lucerne) to give hints about population settlements up to the middle of the 19$^{th}$ century. All data were collected in a data base similar to those from CSCF. A special focus was set on the geographical resolution. If possible the older data were subsumed under a 5 km$^2$-grid. The maximum resolution of data between 1950 and 2004 allowed a 1 km$^2$-grid. The extended species group of xylophagous was divided into three classes of mobility, defined after a literature review and a Delphi study with experts, organized by Winrich Mertens, Entomological Association South Badenia (FREAK), Friburg (SW-Germany).

To analyse the development of beetle distribution we divided the total data set into 4 time steps between 1847 and 1950 and 5 decades between 1951 and 2004.

All data analyses aimed to work out "hotspots" of beetle diversity – defined as grid cells with the highest rank of species diversity inside.

The landscape development round these hotspots is now going to be analysed in several steps: At first the eldest topographic map (normally from the beginning of 19$^{th}$ century, e.g. "Michaelis-Karte", see Fig. 4) will be surveyed in combination with local data sources like forest descriptions, forest taxations or inventories. As a main indicator of harvesting activity the density of road constructions can be assessed easily to identify forest patches with less potential of human disturbance.

In a next step the opportunities of a very early beginning (round 1910) of precise areal photography in Switzerland is used to give hints about the forest structure round and within the hotspot grid cells.

The last step has already been done: We compare the distribution of beetles with the results of the first Swiss Forest Inventory Program (LFI) being published in 1988 (Brassel *et al.*, 1988). As some in LFI assessed variables show a nice relation to the distribution of our beetle hotspots (see below), we hope to improve the correlations with the results of LFI III.

## FIRST RESULTS

As work is ongoing, we can only give some first results:

— Hotspots of xylophagous beetles in Switzerland can be fixed rather clearly. During the surveyed time period they did not change their positions (identity of grid cells including a "security buffer" of their neighbours).

**HABITAT CONTINUITY** *Objekterfassung*

Objekt-Nr.: 0000807
Code: ptinsexp
EDV-Code: 69-.008-.017
Gattung: **Ptinus**
Art: **sexpunctatus**
Autor: Panzer 1795

Region:
Kanton: BE
Gemeinde: BELP
Flurname, Ort: Belp
X: 604542 Y: 193161 1 km2: 5 km2: 600190
Höhe:
Genauigkeit Ortsangabe:
Tag: Monat: 06 Jahr: 1888
Genauigkeit des Datums:

Anzahl Individuen: 1
Häufigkeit:

Lebensraumtyp:
Substrat/Mikrohabitat:

Beobachter/Sammler: lind Linder-Hebeisen Arthur
Bestimmer:

Sammlung: ethz Entomologische Sammlung der ETH Zürich
Zusatz: ex coll. coll. Linder

Quelle:

Anmerkungen: rev. X. Bellé nov. 1991

Erfassungsdatum: 13/06/2005

Figure 1. — Excerpt from the data base of all surveyed xylophagous beetles

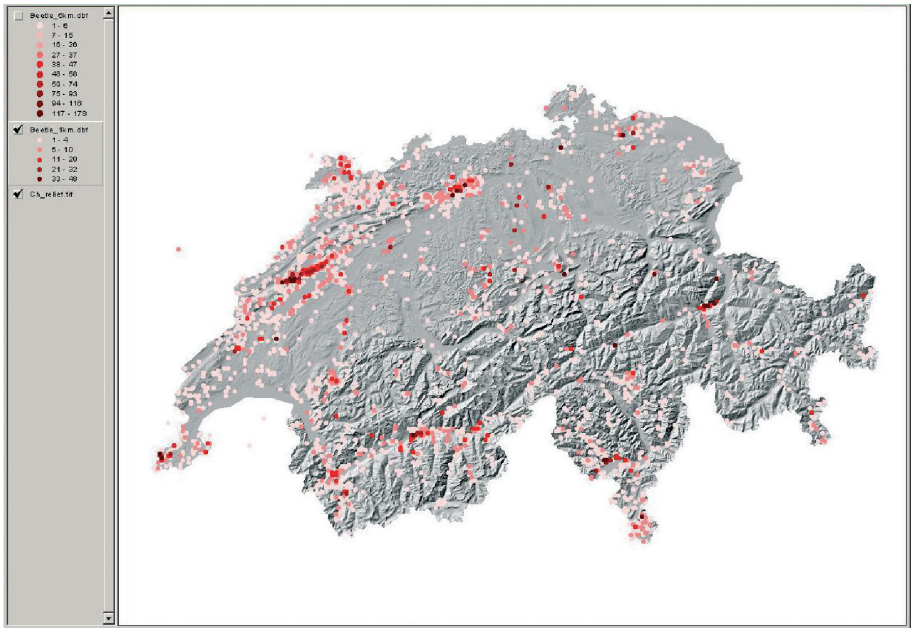

Figure 2. — All mapped beetle species between 1951 and 2004

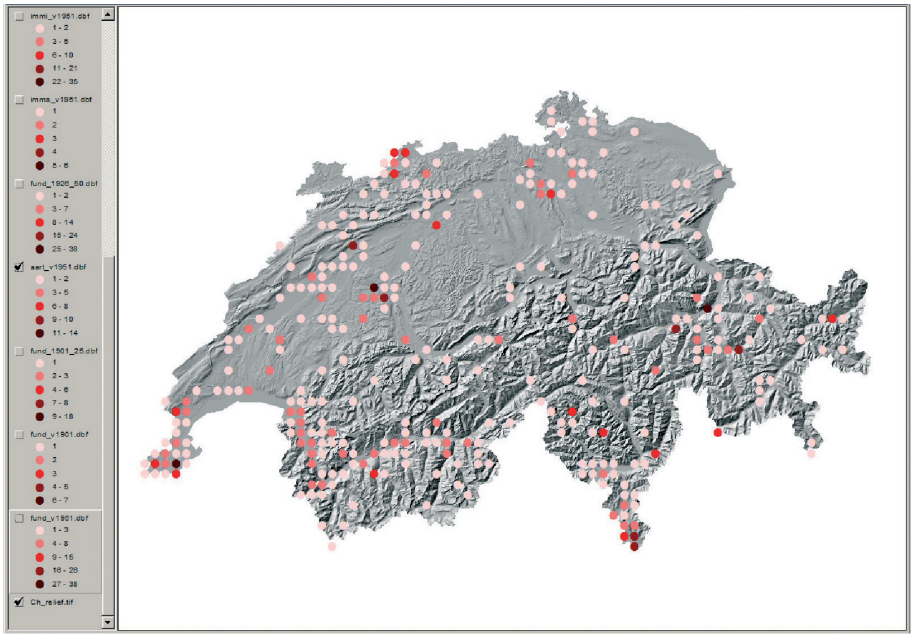


Figure 3. — All mapped beetle species between 1847 and 1950

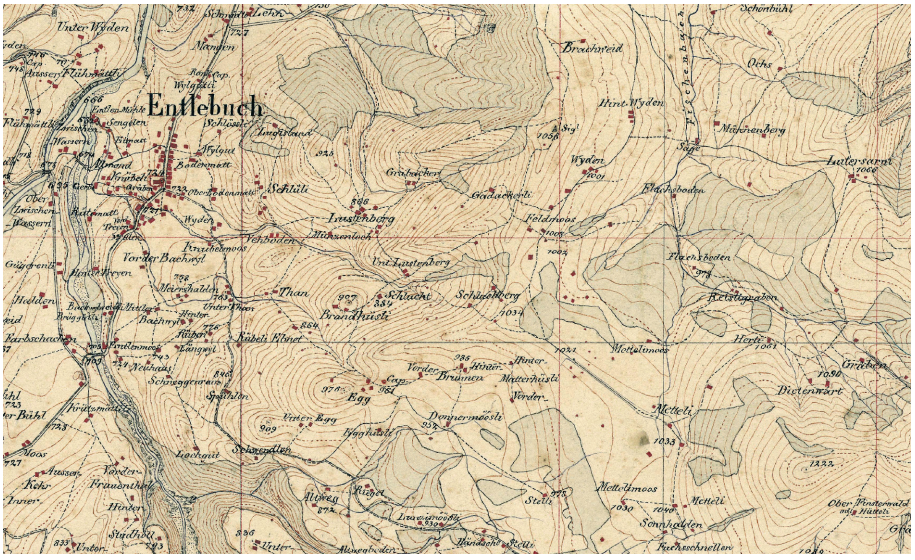


Figure 4. — Historical map from Entlebuch (Excerpt), 1860 – mentions the different road construction situation in forest area.

— In some cases hotspots may only reflect the intensity of survey by collectors. We are elaborating a statistical method (modified Monte-Carlo procedure) to proof the relation between collecting intensity and number of species registered in one grid cell. On the other hand collector's intensity can be voted as indicator too, because the "sustainability of successful collecting" during generations of collectors should reflect high beetle diversity.

— A well-developed forest road construction documented in the eldest topographic seems to be negatively correlated with the species diversity of immobile beetles. This phenomenon is also going to be tested statistically.

— From the variables assessed in LFI the indicator "last exploitation" shows a high grade of correlation to beetle-hotspots: LFI-Plots with no exploitation during more than fifty years are significantly represented in the grid cells (and their "security buffer") of the hotspots ($\chi^2$ test, $p < 0{,}05$).

— A theoretical concept of the importance of habitat continuity has been established and published (Coch, Schmid & Steck 2007 – in German).

— A connected research project dealing with the importance of habitat continuity on grasshopper populations could be finished successfully (Steck, 2007). In his PhD thesis C. Steck was able to explain the influence of habitat continuity even on these highly mobile species. Historic habitat availability explained more of the current biodiversity hotspots (within the grasshoppers) than the recent habitat quality.

In future work we will compare the hotspot-situation within xylophageous beetles between the three groups of mobility. Our hypothesis, derived also from field researches with longhorn beetles (Coch & Voegeli, 2006) and the very rare and rather immobile *Osmoderma eremita* (Scarabaeidae; Voegeli, 2002), provides the dynamic habitat continuity (with possibility of habitat change or loss in functional distances) as a suitable strategy to improve the survival of threatened xylophagous beetles. Depending to the job change of our project leader (Th. Coch) from ETH to the Biosphere Management of the only Swiss Biosphere Reserve in Entlebuch, the projects progress was interrupted in 2007. But we will continue in 2008, adding a new regional focus with detailed data from the Entlebuch.

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## REFERENCES

An extended literature list can be ordered by mail to: t.coch@biosphaere.ch